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AUTHOR Sullivan, David W.
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ABSTRACT

Following the presentation of a conceptual framework for computer-based education (CBE), this paper examines the use of one aspect of CBE, computer-managed instruction (CMI), in a Major Appliance Serving Program. The paper begins with definitions and a graphic illustration of CBE and its components and uses, i.e., CMI, tutorial or computer-assisted instruction, drill and practice, interactive instruction, instructional simulation, and inquiry. Next, a description is provided of Moraine Park Technical Institute's Appliance Servicing Program, a competency-based curriculum with multiple entry and exit points throughout the 45-week program, which offers a multiple-instructional approach for each module of instruction. Information is provided on methods of evaluating student progress toward meeting performance objectives and of evaluating the program. Next, the paper examines the uses of the microcomputer in keeping track of student progress, providing immediate feedback to students, grading and record keeping, inventory control and shop management, and testing. Finally, the paper describes the modifications made to the Radio Shack program, "Quick Quiz," for creating exercises and tests for students in the program. Illustrations are presented throughout the paper to provide further information about the competency-based program and the use of microcomputers in the program's management information system. (LAL)

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# An Application of a Computer Instructional Management Package

A Presentation/Paper
By
David W. Sullivan
Presented at the
"Microcomputers & High Technology Conference"
Aug. 14, 1984.
Madison,WI.

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## Computer-Managed Instruction

The purpose of this paper is to present a conceptual structure of Computer-Based Education (C.B.E.), and to investigate an application of one of the areas of C.B.E. as it is applied in a Major Appliance Servicing Program.

## Computer-Based Education: A Conceptual Framework

Computer-Based Education (C.B.E.) - Encompasses six major areas of computer instruction. The six major areas of computer-based education are: Computer-Managed Instruction (CMI), Tutorial or Computer-Assisted Instruction, and Inquiry. Each of these applications employs the computer in a different role in the instructional process.

Computer-Managed Instruction (C.M.I.) - Relies on the record keeping and summarizing power of the computer to access, diagnose, prescribe, and monitor the learner's progress.

Tutorial or Computer-Assisted Instruction (C.A.I.) - Assumes that the learner is approaching the material for the first time. New material is presented in an expository form followed by (1) questions that the learners are expected to respond to, (2) an analysis of the learner's response, (3) appropriate feedback, and (4) the presentation of new material.

Drill and Practice - assumes certain learned facts or concepts prior to using the program. It may pretest these concepts prior to the presentation, but does not present any new material. Drill and Practice, through a series of questions and responses, provides the learner with an opportunity to practice what has already been learned; usually to some predetermined level of performance.

Interactive Instruction - Subsumes the concepts of Tutorial and Drill and Practice. It presents the instructional material to the learner, accepts and judges responcses, provides the learner with feedback, and alters the flow of subsequent instructional material depending on the level and the responses of the learner. Interactive Instruction may also include a variety of other hardware and software of courseware such as: videotape or disc, schematic wiring diagrams, graphs or workbooks.

Instructional Simulation (C.I.S.) - Causes the learner to apply, analyze, intergrate, and synthesize their own knowledge as they solve real life problems that have been simulated and stored in the computer's memory.

Inquiry - Uses the ability of the computer to serve as a resource and tool in aiding the person to solve a particular problem.

The separate research and development projects in C.B.E. over the years can be synthesized into a single conceptual map which relates

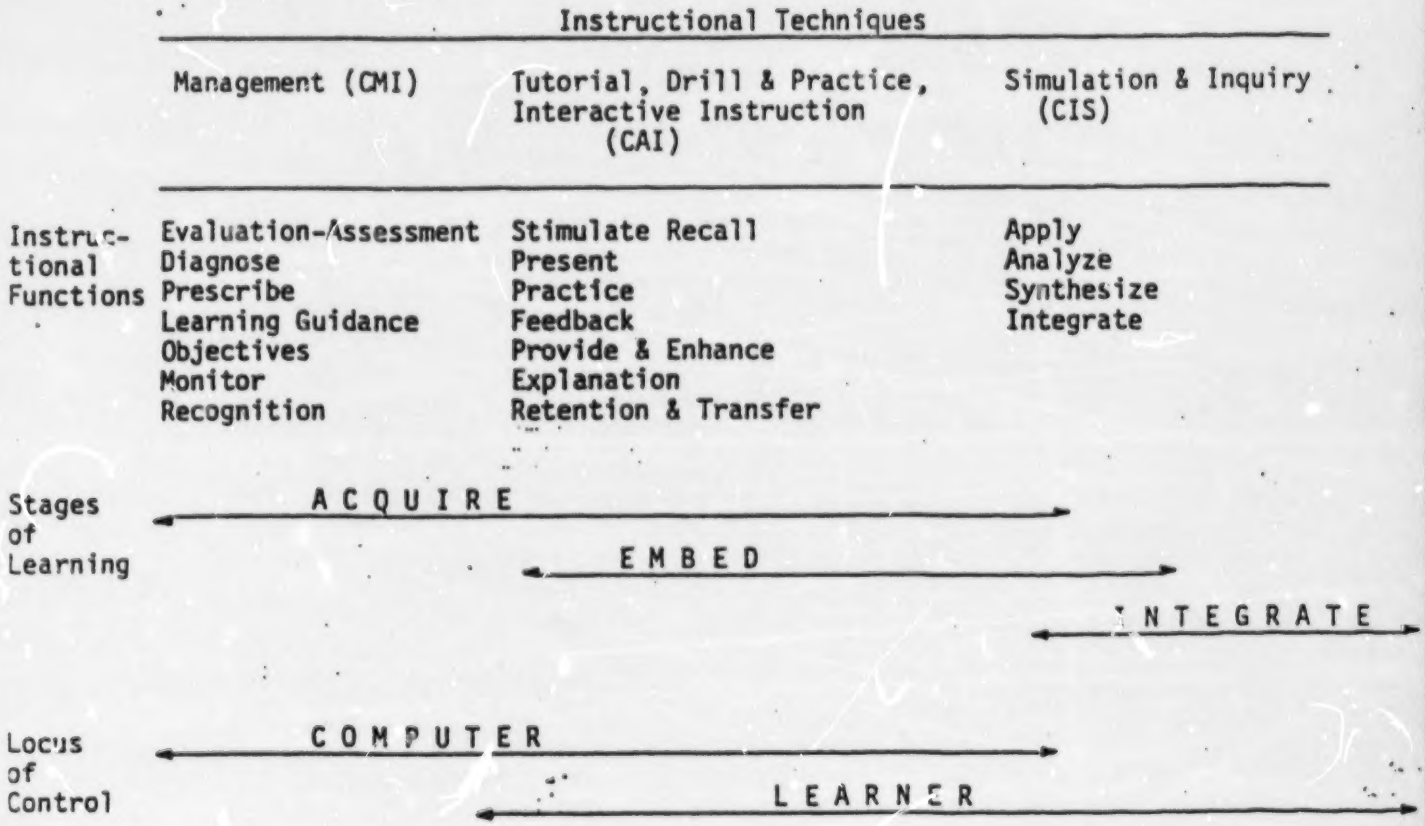



Figure 1. Conceptual map of instructional functions and requirements of CBE techniques. (Keith Hall, 1982 - modified version Dave Sullvan, 1983)

Each succeeding instructional technique (moving up the hierarchy in Figure 1) requires (1) all of the learner knowledge, skills, and behaviors provided by the preceding stage, and (2) all of the curricular products produced by the preceding stage. Therefore, it is posited that the sequence for developing C.B.E. courseware should proceed from Computer-Managed Instruction (C.M.I.) to Instructional Simulation and Inquiry.

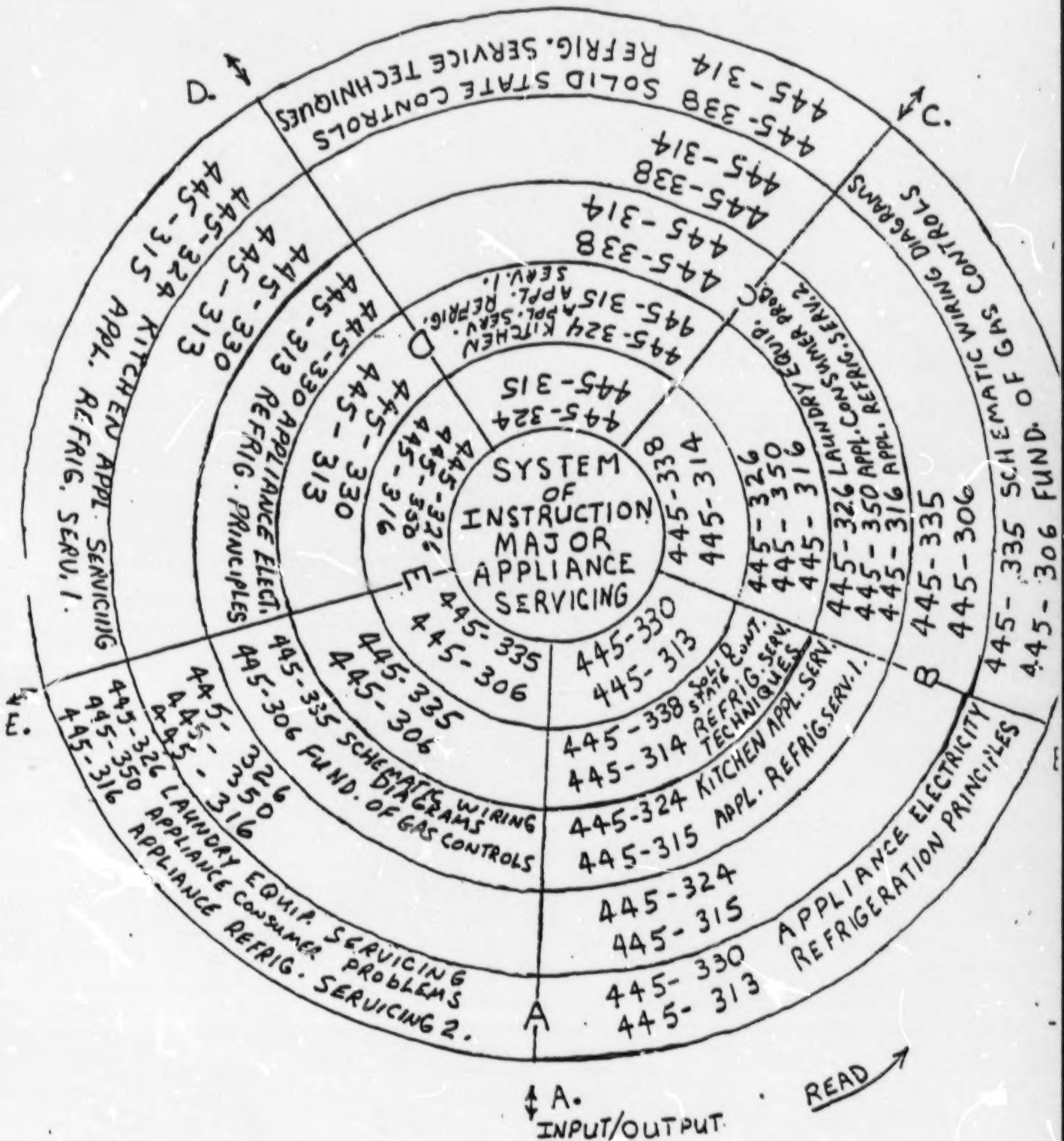
(Keith Hall - Director of Computer-Based Education and Professor of Education at the Ohio State University, Columbus, Ohio.)

instructional function to the instructional techniques of C.B.E. (Figure 1). Each of the instructional techniques employs the computer in a different role in the instructional process... These instructional techniques are arranged in an ascending hierarchy (from left to right in Figure 1) which reflects the increasing complexity of both instructional tasks and learning tasks as the learner moves throught the stages of learning...

## C.M.I. Rationale

The Appliance Servicing program of Moraine Park Technical Institute is a competency-based curriculum, which has multiple entry and exit points throughout the 45-week program.. Students may enter or exit the Appliance Servicing Program every nine weeks. The curriculum has two levels. Level one is the "basics" (electricity, refrigeration, schematics, gas controls, etc.); level two is equipment servicing courses. In the various equipment servicing courses, sixteen major appliances are covered: automatic washers, dryers, dishwashers, compactors, garbage disposals, microwave ovens, convection ovens, water heaters (gas and electric), electric ranges, gas ranges window air conditioners, window heat pumps, dehumidifiers, refrigerators, freezers, and ice makers. A student must complete the "basic" section, level one of the program, before enrolling in any of the equipment courses in level two. The student may, however, enroll for any of the equipment courses once the "basics" are completed.

A multiple-instructional approach is available for each module of instruction. Students have textbook and handout reading assignments. They must answer the questions following each module in the student workbook. There are audio-visual presentations for each module that students amy view in the appliance servicing learning lab. There may also be individualized assignment sheets for the students to complete. The student also attends lecture-discussions, demonstrations, and completes lab assignments.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445-306 FUND. OF GAS CONTROLS
445-338 SOLID STATE CONT.
445-314 REFRIG. SERV. TECHNIQUES
445-324 KITCHEN APPL. SERV. 1.
445-315 APPL. REFRIG. SERV. 1.
445-326 LAUNDRY EQUIP. CONSUMER PROB.
445-350 APPL. REFRIG. SERV. 2.
445-316 APPL. REFRIG. SERV. 1.
445-335 SCHEMATIC WIRING DIAGRAMS
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445-324 KITCHEN APPL. SERVICING
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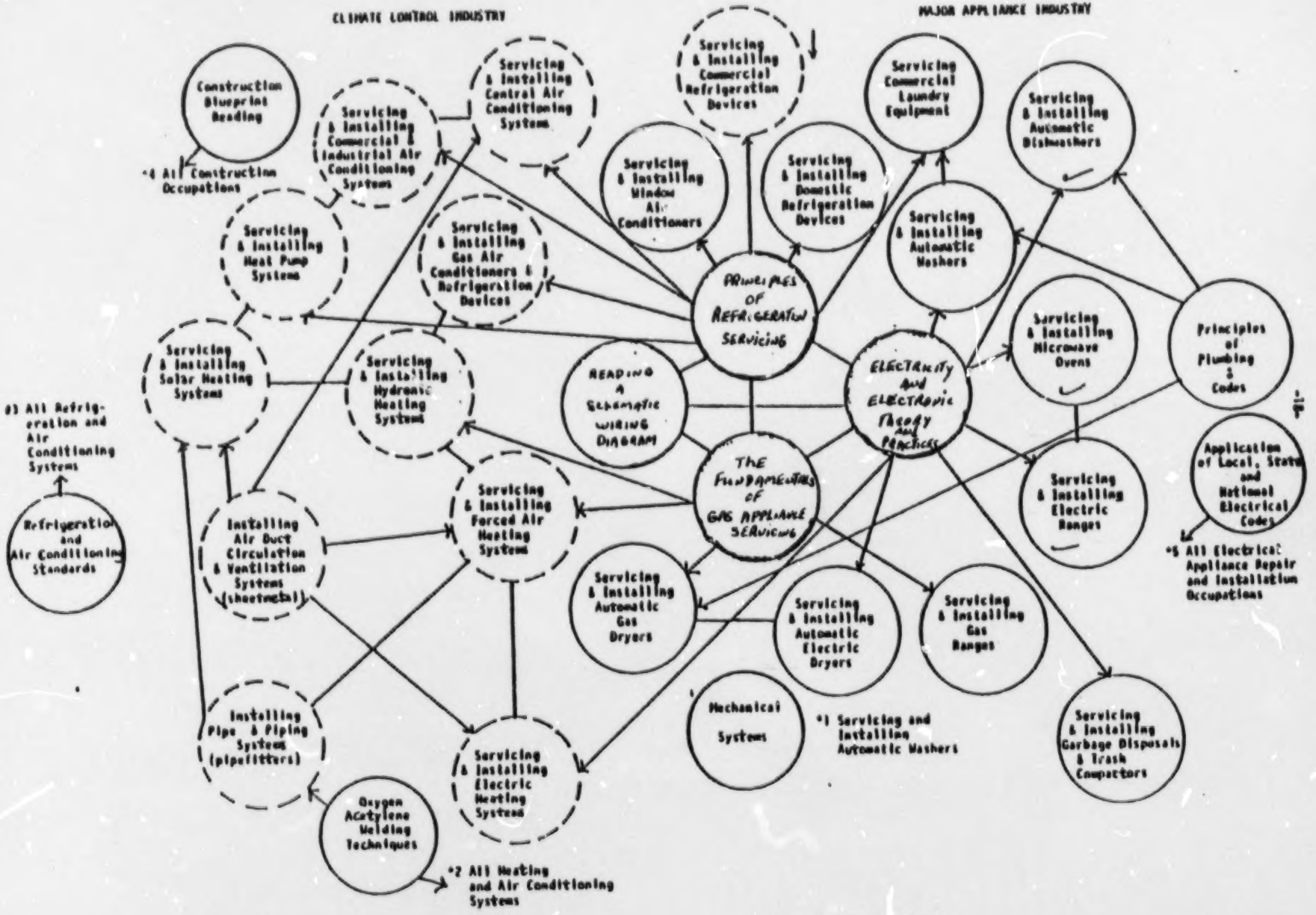
CLIMATE CONTROL INDUSTRY
MAJOR APPLIANCE INDUSTRY
Construction Blueprint Reading
*4 All Construction Occupations
Servicing & Installing Commercial & Industrial Air Conditioning Systems
Servicing & Installing Central Air Conditioning Systems
Servicing & Installing Commercial Refrigeration Devices
Servicing Commercial Laundry Equipment
Servicing & Installing Automatic Dishwashers
Servicing & Installing Window Air Conditioners
Servicing & Installing Domestic Refrigeration Devices
Servicing & Installing Heat Pump Systems
Servicing & Installing Gas Air Conditioners & Refrigeration Devices
Servicing & Installing Automatic Washers
PRINCIPLES OF REFRIGERATION SERVICING
Servicing & Installing Solar Heating Systems
Servicing & Installing Hydronic Heating Systems
READING A SCHEMATIC WIRING DIAGRAM
ELECTRICITY AND ELECTRONIC THEORY AND PRACTICES
Servicing & Installing Microwave Ovens
Principles of Plumbing & Codes
*3 All Refrigeration and Air Conditioning Systems
Refrigeration and Air Conditioning Standards
Installing Air Duct Circulation & Ventilation Systems (sheetmetal)
Servicing & Installing Forced Air Heating Systems
THE FUNDAMENTALS OF GAS APPLIANCE SERVICING
Servicing & Installing Electric Ranges
Application of Local, State and National Electrical Codes
*5 All Electrical Appliance Repair and Installation Occupations
Servicing & Installing Automatic Gas Dryers
Servicing & Installing Automatic Electric Dryers
Servicing & Installing Gas Ranges
Mechanical Systems
*1 Servicing and Installing Automatic Washers
Servicing & Installing Garbage Disposals & Trash Compactors
Installing Pipe & Piping Systems (pipefitters)
Servicing & Installing Electric Heating Systems
Oxygen Acetylene Welding Techniques
*2 All Heating and Air Conditioning Systems



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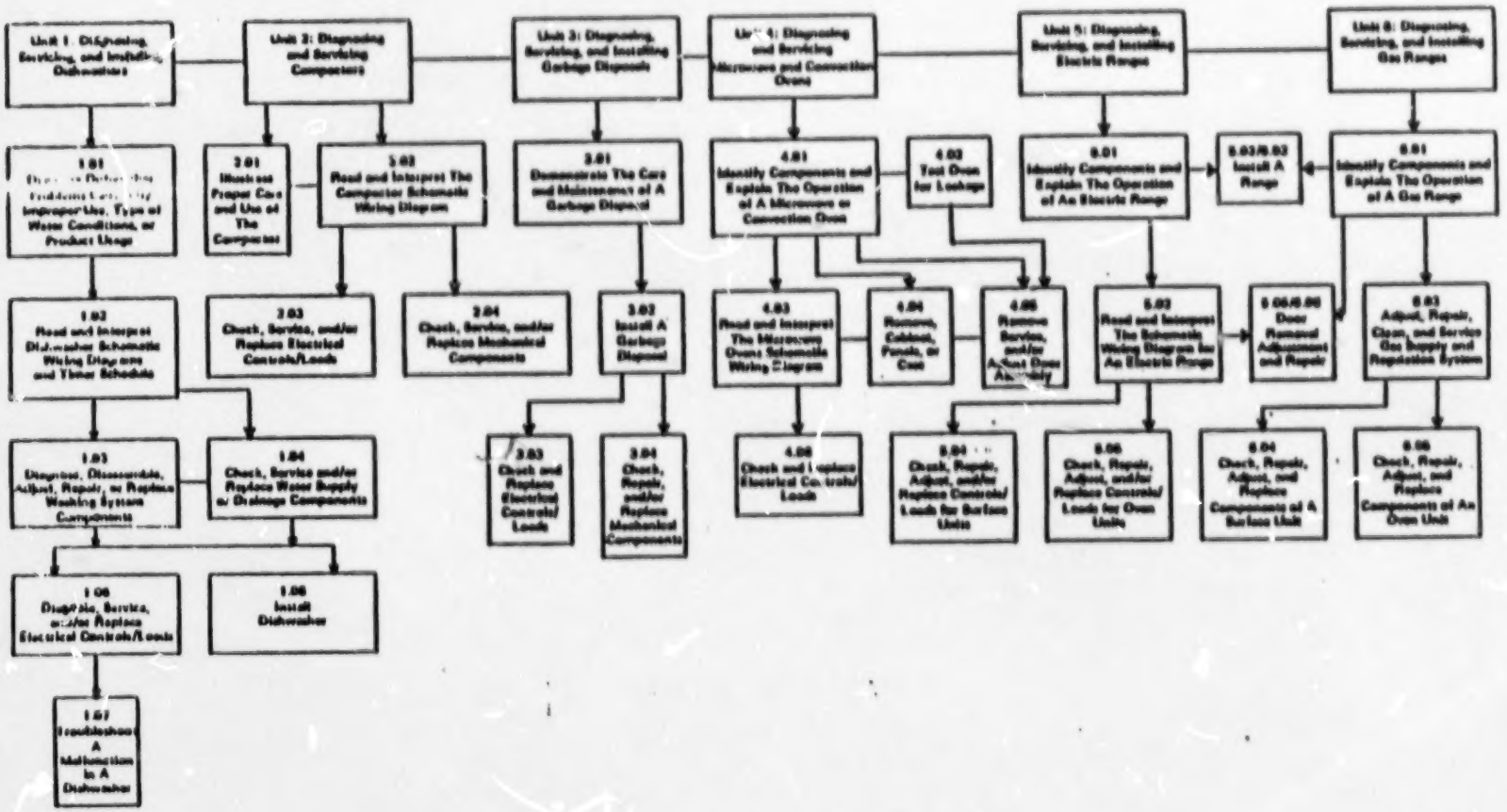
## INSTRUCTIONAL FLOW CHART
## KITCHEN APPLIANCE SERVICING 446-324


Unit 1: Diagnosing, Servicing, and Installing Dishwashers
Unit 2: Diagnosing and Servicing Components
Unit 3: Diagnosing, Servicing, and Installing Garbage Disposals
Unit 4: Diagnosing and Servicing Microwave and Convection Ovens
Unit 5: Diagnosing, Servicing, and Installing Electric Ranges
Unit 6: Diagnosing, Servicing, and Installing Gas Ranges
1.01 Improper Use, Type of Water Conditions, or Product Usage
1.02 Read and Interpret Dishwasher Schematic Wiring Diagram and Timer Schedule
1.03 Diagnose, Disassemble, Adjust, Repair, or Replace Washing System Components
1.04 Check, Service and/or Replace Water Supply or Drainage Components
1.05 Diagnose, Service, and/or Replace Electrical Controls/Loads
1.06 Install Dishwasher
1.07 Troubleshoot A Malfunction in A Dishwasher
2.01 Illustrate Proper Care and Use of The Compactor
2.02 Read and Interpret The Compactor Schematic Wiring Diagram
2.03 Check, Service, and/or Replace Electrical Controls/Loads
2.04 Check, Service, and/or Replace Mechanical Components
3.01 Demonstrate The Care and Maintenance of A Garbage Disposal
3.02 Install A Garbage Disposal
3.03 Check and Replace Electrical Controls/ Loads
3.04 Check, Repair, and/or Replace Mechanical Components
4.01 Identify Components and Explain The Operation of A Microwave or Convection Oven
4.02 Test Oven for Leakage
4.03 Read and Interpret The Microwave Oven Schematic Wiring Diagram
4.04 Remove, Calibrate, Preset, or Test
4.05 Remove, Service, and/or Adjust Door Assembly
4.06 Check and Replace Electrical Controls/ Loads
5.01 Identify Components and Explain The Operation of An Electric Range
5.02 Read and Interpret The Schematic Wiring Diagram for An Electric Range
5.03/5.04 Install A Range
5.05/5.06 Door Removal Adjustment and Repair
5.01 Identify Components and Explain The Operation of A Gas Range
5.03 Adjust, Repair, Clean, and Service Gas Supply and Regulation System
6.01 Check, Repair, Adjust, and/or Replace Controls/ Loads for Surface Units
6.02 Check, Repair, Adjust, and/or Replace Controls/ Loads for Oven Units
6.04 Check, Repair, Adjust, and Replace Components of A Surface Unit
6.05 Check, Repair, Adjust, and Replace Components of An Oven Unit

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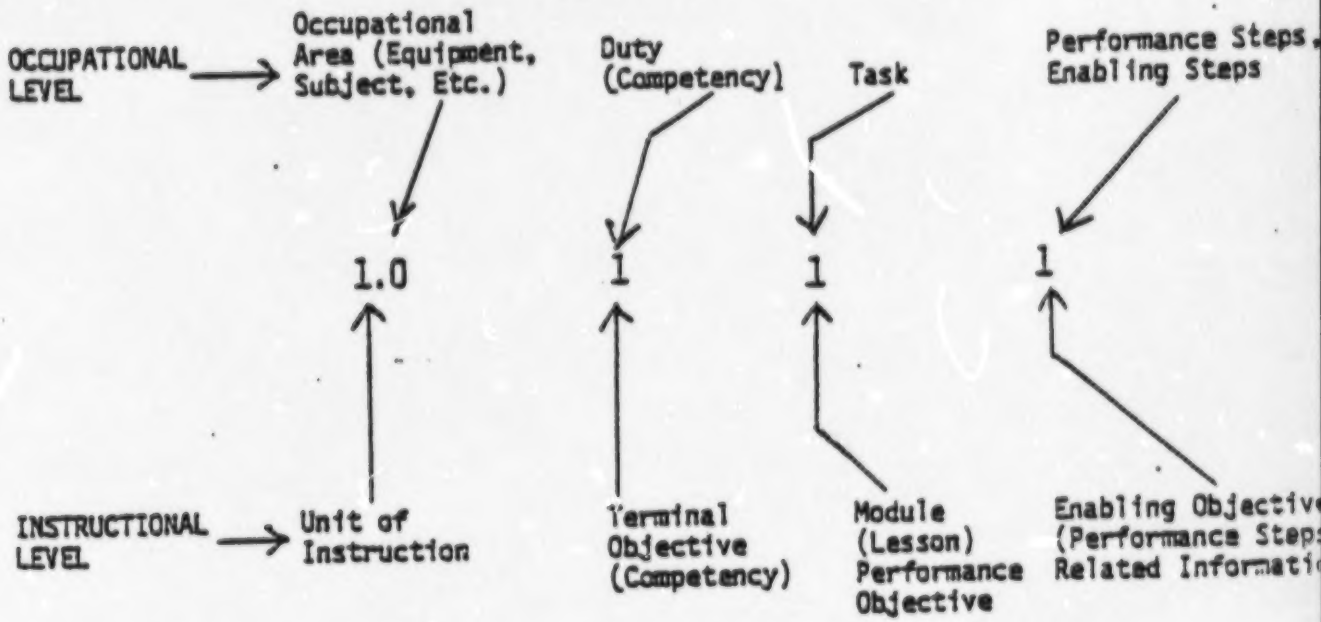
MORAINE PARK TECHNICAL INSTITUTE
Fond du Lac, Wisconsin

## NUMBERING SYSTEM




EXAMPLE:

Occupation: Major Appliance Service Technician
Occupational Area: Servicing Window Air Conditioners

| 445 | - | 315 | - | 1. | 02 | 1 |
|---|---|---|---|---|---|---|
| Major Appliance Servicing | | Course Number: Appliance Refrigeration Servicing-1 | | Unit 1: Servicing Air Conditioners | Competency: Performance Checking Window Air Conditioners | Module: Using Performance Tables |

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PERFORMANCE STEPS:

1.0211 Prepare the Air Conditioner for Conducting the Performance Check.

1.0212 Take and Record a Wattage Reading on the Air Conditioner Using a Wattmeter.

1.0213 Take and Record Dry Bulb Temperature Reading in the Condenser Air Inlet Stream.

1.0214 Take and Record Wet and Dry Bulb Sling Psychrometer Readings at the Inlet to Evaporator Air Stream.

1.0215 Take and Record Dry Bulb Temperature Reading of the Air Coming Out of the Evaporator Discharge Grille.

1.0216 Calculate Differential Dry Bulb Temperature.

1.0217 Using a Performance Chart and Previously Recorded Data, Determine the Performance Level of the Air Conditioner.

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The evauluation for each module is a criterion-referenced test which may consist of a written or a proactical evaluation, or perhaps a combination of both, based on the performance objectives.

Each objective is identified by a number which identifies the program, course, unit of instruction, competency, task, enabling objectives and related information. Performance steps are also identified and sequenced by this numbering code. A progress and evaluation report keeps track of each student's progress in the achievement of competencies (job duties), and tasks levels. Enabling objectives may be performance steps or related information. Enabling objectives are not charted or may not be specifically evaluated, however are guides in the instructional process.

The collection and analysis of evaluation information is necessary to facilitate changes in occupational courses or programs. For example, data which shows that students are not performing to employer expectations may result in a need to review competency information which, may in turn, lead to a revision in student performance objectives and instructional methodology.

The evaluation of the Appliance Servicing Program is accomplished by: student evaluation of the course, student follow-up survey, employer survey, cost analysis, results of student exams, job placement, instructor's self-evaluation of program, and occupational advisory committee evaluation. A composite report of all evaluations is written to provide data for program change and improvements.

The microcuomputer becomes almost a necessity to keep track of the progress of students as they progress at different levels throughout the appliance servicing program and provide the necessary management information for the system.

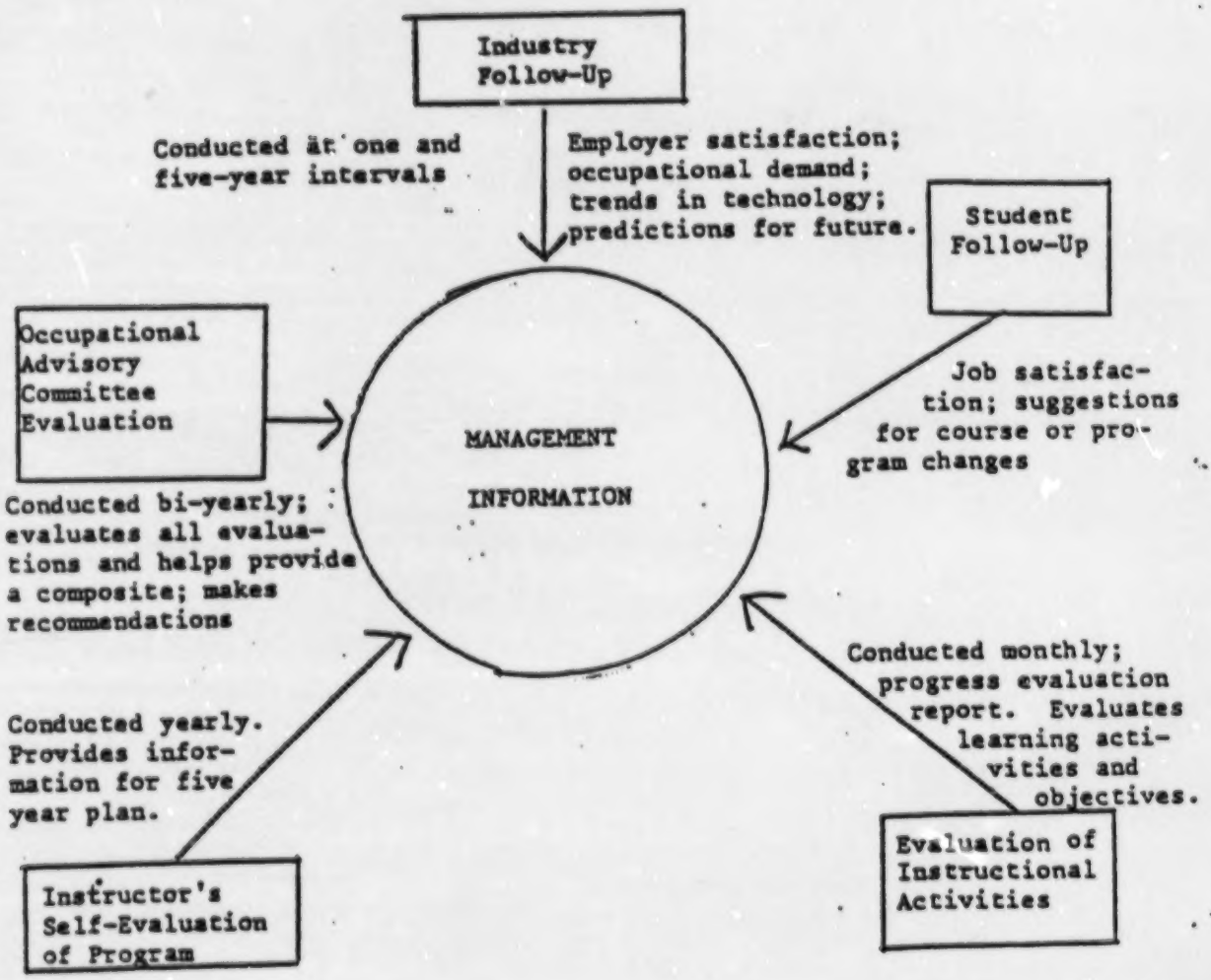
A critical fractor in any learning system is feedback. Feedback, in order to be effective, should be immediate. Unfortunately, most teachers cannot correct each test within minutes of its completion, monitor every learning event, and provide this feedback. But, a microcomputer can do this and more. The computer points out the error as soon as it is entered by the student. It can provide a review at the end of the lesson. The student is also given a summary of his or her performance. The average teacher finds it difficult, to say the least, trying to chart each student's progress in an open-entry/exit competency-based curriculum. However, this feedback is necessary for proper management of the program. The microcomputer can also provide this much needed management of information. At any time during the year, the teacher or student should be able to view his/her achievements at any level. The computer can provide for printouts on individual tests or students, make the reporting of final grades a considerably easier task for the teacher, and provide the management information necessary to upgrade course objectives, tests, lab assignments, learning activities, and curriculum changes. the weakest link in the instructional system of many competency-based programs is the management of information for the

system. The goal was to develop a management information system on a micrcomputer which will chart and record student progress in listed competencies, record criterion referenced tests, diagnose, prescribe, provide learning guidance, monitor, and recognize student achievement.

Computer-Managed Instruction

The Computer-Managed Instruction (C.M.I.) described in this paper is part of a Management Information System (M.I.S.) developed by this author in a personal philosophy of vocational technical education. A system for management of feedback information from follow-up studies, program evaluations, and instructional activities is necessary to modify program objectives, instructional activities, update equipment, etc. The M.I.S. must be continuously providing the system with information on student success in instructional activities in order to be effective.

## Management Information System (M.I.S.)


Industry Follow-Up
Conducted at one and five-year intervals
Employer satisfaction; occupational demand; trends in technology; predictions for future.
Student Follow-Up
Occupational Advisory Committee Evaluation
Job satisfaction; suggestions for course or program changes
MANAGEMENT INFORMATION
Conducted bi-yearly; evaluates all evaluations and helps provide a composite; makes recommendations
Conducted monthly; progress evaluation report. Evaluates learning activities and objectives.
Conducted yearly. Provides information for five year plan.
Instructor's Self-Evaluation of Program
Evaluation of Instructional Activities

## Grading & Progess Record Keeping

Appliance Servicing has a program that was modified from an original Radio Shack Program called "Teacher Aide". Another program was written and integrated with the program to provide for charting and recording student progress in listed competencies and record test scores from criterion referenced tests for the Appliance Servicing Program of Moraine Park Technical Institute. The computer program provides the following information and processes:

1. Provides a file of students locatable by a class name or course number which would contain the student's name, student I.D. number, and Social Security number.
2. Records and processes a file of test results, grades should be locatable by student I.D. or class name or number, and the test name.
3. Provides for the addition or deletion of a student from the student file.
4. Provides for the deletion of an entire classes' test results, a class list of students, or change test results for an individual student.
5. Prints a list of students enrolled in a given class.
6. Posts the test results by student Social Security numbers for a given test.
7. Prints a statistics sheet for a given test and class.
8. Views the progress of an individual student on the screen or prints a "hard copy".
9. Records and processes a file of tasks or competencies.
10. Prints a competency results sheet for an individual student which would show the tasks completed, the grade, and also those not yet completed.
11. Provides for a file of task projects, allows the addition, delection, listing, or provides for a change in any or all of the projects in the master project file.
12. Kills and provides for initialization of any and all files of the system.

## Inventory Control and Shop Management

The entire parts inventory for Appliance Servicing which includes the parts store, as well as used parts salvaged form machines and items stocked in the lab, are listed in an inventory program designed for management of parts.

The shop management of the Appliance Servicing Program of Moraine Park resembles, as closely as possible, the procedures and practices in an actual appliance business. Inventory control, although a tedious job, is a necessity in any business. The Inventory Control System (ICS) makes this job easier and saves money in the process.

This system assists in cycle counting, ordering parts, allows you to custom design your own parts, posts receipts, prepares labels, gives you complete maintenance of files - add, delete, inquire/edit and list -tracks usuage, reorder points, and provides a suggested order

list by vendor.

Another program, Profile III Plus, which is a personalized electronic filing system, is used to keep records on all appliances owned by the school and those repaired as part of the students' training. Reports can also be generated which list every appliance an individual student has worked on during his/her 45 weeks of training, what the problem was, what work was accomplished, etc. This program is also being used to keep other records vital to the operation of the Appliance Servicing Program. Other programs also assist in the day-to-day operation.

Testing on the Computer

A major modification of the Radio Shack program, "Quick Quiz", by Bruce DeBoer of Moraine Park Technical Institute, allows the instructor to create exercises and/or quizes/tests in any subject area. The modified menu-driven authoring system uses multiple choice, fill in the blank, true/false, or matching formats. It allows editing and has students record keeping and reports capabilities. Questions are placed in a data bank and may be called out all or part for presentaion to the student in either a random or in normal sequence pattern. Tests can be administered at the computer, or can be printed out using a line printer. Bruce has also developed an orignal authoring system on the IBM P.C.

The original Quick Quiz program was modified to include the following changes.

1. Passwords were provided to prevent student access to the author modes.
   a) CREATE allows the author access to all aspects of the program. The shifted ":" allows return to menu at almost any time.
   b) REPEAT allows the author to choose an exam to be repeated as many times as desired.
   c) SINGLE allows the author to indicate that the exam should only be given one time and not repeated.
   d) DRILLS allows the student to choose exams (drills) from a MENU and he/she may return to the MENU to choose more drills whne finished.

2. Questions may be EDITED DURING the CREATE mode.

3. NEW QUESTIONS may be ADDED to the exam DURING the EDIT mode.

4. The author may create an up to 40 question exam with an up to two line (120 character) AUTHORED FEEDBACK response to an incorrect response.

5. The author may CREATE an up to 20 question exam with an up to two line (120 character) AUTHORED FEEDBACK

a) Each incorrect answer choice may have its own response explaining why the choice is not the best.
b) Each answer correctly chosen on the first try is provided with a simple, randomly selected (from six) response such as CORRECT!.
c) If the correct answer is chosen after the first try the CORRECT! etc. is provided following by the AUTHORED FEEDBACK explaining why the answer is the best choice.
d) If the correct answer is not chosen in a number of trys equal to the number of responses, the correct answer is indicated followed by the explanation feedback.

6. The author may determine how the test is to be presented. The author may indicate whether the test is to be delivered as a STRAIGHT SEQUENCE exam OR RANDOM exam.
a) The number of questions authored may be more than the number offered on the student exam. EXAMPLE: The test may have 40 QUESTIONS in the BANK but only 20 QUESTIONS SELECTED AT RANDOM on the student exam. The same question is not presented twice during the presentation of the random exam. A test may be changed form straight to random or vice versa during the edit mode.

7. The student is provided with a LISTING of the data bank question numbers of the PROBLEMS MISSED so that the exam results may be discussed with the instructor an any time on a later date.

8. An AUTHORED MENU is generated for listing of EXAMS presently being used. Tests are administered without having to type in filenames. This provides for the ease of use of the program for authored DRILL and PRACTICE.

9. MENU of ALL FILES on diskette are provided for the purpose of EDITING, KILLING FILES, and PRINTOUT. Files are selected through the simple input of a 1 or 2 digit number without having to type in filenames.

10. Printouts are now properly formatted even if the AUTHOR uses the spacebar rather than the down arrow to go to the next line during authoring of questions.

11. NOTE: Since the above items were first written, a new feature was added. The author may now create a test of COMPLETION items with up to four acceptable answers per question.

Additional programming note: The original edit commands (N) and (P) were retained, but the P command does not function when in the CREATE mode.

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